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Fog interception and redistribution of rainfall by vegetation as controlling factors of recharge rates: a case-study in Galápagos Islands

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Evaporation losses reduce the amount of available water below vegetation canopy, so that only a portion of rainfall is redistributed to throughfall and stemflow. Yet, the occurence fog reduces evaporation and the interception of fog droplets may be a non negligible additional input of water. Furthermore, the redistribution of rainfall by the vegetation induces localized dripping points on the soil, which may lead to preferential flow paths and enhance infiltration rates. As a consequence, the intensity and spatial variability of throughfall should not be neglected for accurate estimations of groundwater recharge.

In the frame of the Galápagos Islands Integrated Water Studies project (GIIWS), throughfall monitoring has been performed during the 2010 fog season, locally known as "garúa" season at two 6x6m plots along the windward slope of Santa Cruz Island. The lower site (450 m.a.s.l., 8 km from the coast) is covered by a 4-7 m high introduced mixed forest. The highest plot (650 m.a.s.l, 10 km from the coast) is covered by 1-2 m high homogeneous endemic evergreen shrubs. It is more exposed to winds, and subjected to denser and more regular fog occurrence. On both sites, measurements with sets of 3m-long collecting troughs dipping to an automatic gauge have been accompanied by a dense network of small collectors, 30 cm in diameter. The automatic gauges have been calibrated on-site and an estimation of error has been done to validate the results. Besides, we verified that the sampled areas were sufficiently large to obtain representative measurements at reasonable confidence intervals.

The small collectors have highlighted the high spatial variability of throughfall at the plot scale. This was explained by the existence of major dripping points and the shading effects of leaves. Interestingly, changes in the canopy caused by the fall of branches or the development of understory vegetation affected the spatial distribution pattern of throughfall. Yet, coefficient of variations remained roughly the same along the five months of this study.

At the regional scale, we observed marked differences between the two monitored sites. The lower site was characterized by relatively weak throughfall rates ($\sim$70% with respect to rainfall). This was explained by the prevalence of evaporation over fog interception. The highest plot (650 m.a.s.l) was characterized by high relative throughfall ($\sim$130% with respect to rainfall), interpreted as the input from fog interception and lower evaporation rates.

The consequences of these observations on groundwater recharge are finally discussed. We show that the spatial variability of throughfall at the plot scale and the contrasting influence of fog at the regional scale can be important controlling factors of the regional hydrogeology.